

3.—The *Amphibolurus reticulatus* species-group (Lacertilia, Agamidae) in Western Australia

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Abstract

The *Amphibolurus reticulatus* species-group consists in Western Australia of four species: *A. pictus* Peters, *A. reticulatus* (Gray), *A. inermis* (De Vis), and *A. clayi* nov. *A. inermis*, which has long been confused with *reticulatus* or regarded as a subspecies of the latter, is shown to be a full species; neither it nor *reticulatus* is divisible into geographical races. In Western Australia, *pictus* breaks up into two races, *salinarum* nov. and *pictus*.

Introduction

This paper is mainly concerned with two closely related and abundant species, *reticulatus* and *inermis*. The other species dealt with, *pictus* and *clayi*, are considerably more distant both from each other and from the first two species. The present species-group is therefore not nearly so homogeneous as the recently investigated *Amphibolurus maculatus* group (Storr 1965).

Failing to distinguish *inermis* from *reticulatus*, many authors have regarded the latter as unusually variable. Actually *reticulatus* undergoes no more individual variation than other species of *Amphibolurus*, and a good deal less geographic variation than most of them, even though it ranges over a quarter of the continent. Its sibling, *A. inermis*, is even less variable throughout its considerably greater area of distribution. Loveridge (1934) was aware that two taxa were involved in the *reticulatus* of authors, but his material was too scanty to reveal their wide sympatry, and he relegated *inermis* to a subspecies of *reticulatus*.

Though described nearly a century ago, *pictus* remains a little known species. Its poor representation in collections is probably due to its specialised habitat preferences. The fourth species, *clayi*, is much rarer still and to my knowledge was not collected until 1931 when Otto Lipfert obtained two on the Canning Stock Route. Another species belonging to this group, *A. decresii* (Duméril & Bibron), is not certainly known from outside South Australia. The MCZ female from Boulder, hesitantly identified by Loveridge as *decresii*, is almost certainly an *A. pictus salinarum*. Its tail and snout-vent length are much the same as in our R 13409, a female possibly collected at the same saltlake.

In the lists of material examined, all specimens with an R number are lodged in the Western Australian Museum; K numbers are of specimens kindly lent by Dr. A. Kluge of the University of Southern California; NTM numbers are of specimens kindly lent by Mr. K. R. Slater of the Animal Industry Branch, Northern

Territory Administration, Alice Springs; SAM numbers are of specimens kindly lent by Mr. F. J. Mitchell of the South Australian Museum; and unnumbered specimens prefixed with WHB are of material collected by Mr. W. H. Butler jointly for the Western Australian Museum and the Archbold Collections of the American Museum of Natural History. Unless indicated to the contrary, all localities are in Western Australia; they are listed under Land Divisions in a generally north-south, west-east sequence.

Diagnosis

The *reticulatus* group consists of stout, terrestrial (usually burrowing) lizards with relatively short head, tail, limbs and digits, a considerably depressed body, and relatively smooth lepidosis. Nuchal scales, except along midline, very small (almost granular). Dorsolateral body scales little larger, but they and dorsals (which increase in size towards midline) may be mixed with large, flat, generally whitish scales arranged in approximately transverse rows. No dorsal crest. Subdigital lamellae very sharply bicarinate. Femoral and preanal pores present in both sexes and juveniles.

Dorsal colour pattern usually consists of either (1) a series of dark blotches along each side of midline, alternating with pale transverse bars or rows of spots; or (2) a dark reticulum. Both kinds of pattern may be present within a single taxon, either as individual, age or sexual variants.

Distribution

The *reticulatus* group is widespread in arid to subhumid habitats of continental Australia. The four species occurring in Western Australia have a collective range throughout the State, except for the far southwest corner where the annual rainfall exceeds 20 inches.

Key to Western Australia taxa

1. a. Nostril on or above swollen rostral ridge 2
- b. Nostril below acute rostral ridge 3
2. a. Femoral pores closely spaced along a straight line parallel and close to outer edge of thigh *reticulatus*
- b. Femoral pores widely spaced along a curve that approaches inner edge of thigh *inermis*
3. a. Pores more than 30; nostril circular or broadly elliptical 4
- b. Pores 10 or fewer; nostril slit-like or narrowly elliptical *clayi*
4. a. No nuchal crest; dorsal scales heterogeneous *pictus salinarum*
- b. Low nuchal crest; dorsal scales homogeneous *pictus pictus*

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***Amphibolurus pictus salinarum* subsp. nov.**

Holotype.—R 17649, in Western Australian Museum, an adult male collected by G. M. Storr on December 2nd, 1962.

Type locality.—Norseman, Western Australia, in lat. 32° 10' S and long. 121° 46' E.

Distribution.—Western Australia south of latitude 27° S and between longitudes 117° and 125° E.

Diagnosis.—Distinguished from nominate *pictus* by its heterogeneous dorsal scales.

Description.—Medium-sized with body and basal half of tail moderately depressed. Head longer, narrower (82% of its length) and less deep (59% of its length) than usual in this group. Relative length of tail exceeded in this group only by nominate *pictus*. Adpressed hindleg reaches to shoulder (females) or tympanum (males). Toes slightly compressed, their outer edge weakly denticulate. Maximum snout-vent length: males 68.5, females 70. Gravid females range from 56.5 to 68. Smallest juvenile 31.

Nostril below moderately acute rostral ridge, a little nearer to orbit than tip of snout, circular or broadly elliptical, and entering forward and downward. Supraciliary ridge acute. Tympanum a little smaller than orbit, its diameter averaging 17% of length of head. Rostral and mental well developed. Upper labials 12-17, smooth, smaller than adjacent facials. A series of enlarged scales extends back from postinferior corner of nasal, below orbit to above ear; at first the scales are flat and smooth but become tectiform under orbit and larger and higher as they curve up towards ear. A loose fold, studded with conical scales 2-3 times as large as neighbouring granules, extends obliquely up from below ear until it joins middle of a similarly scaled dorsolateral fold on neck. No nuchal crest, but a series of subtubercular scales along midline, broader than long, only a little larger than neighbouring scales. No dorsal crest. Strong gular fold curving obliquely back to above shoulder. Frequently a weak preular fold. No dorsolateral fold on body. Femoral and preanal pores 36-55, slightly raised when gorged, each located in a notch on posterior edge of an enlarged scale and margined by 2-4 small unnotched scales. Subdigital lamellae 21-28 under fourth toe, spinosely bicarinate, the inner series of spines much the higher.

Scales on top of head low, smoothest and largest along midline. Occipital scales smaller and rougher. Scales on nape very small, smooth, subconical. Lateral scales similar, but mixed with scales that are smooth or feebly keeled and 2-3 times as large as ordinary laterals. Dorsal scales increase in size towards midline, flatter and more imbricate than nuchals and laterals, and mixed with smooth non-imbricate scales 2-4 times as large as ordinary dorsals and tending to be arranged in transverse rows. Caudal scales much larger than dorsals, smallest laterally, weakly imbricate, moderately keeled. Scales on dorsal and anteroventral surface of limbs similar to caudals but more strongly imbricate. Scales of under surface of foreleg and ventrolateral scales of outer surface of hindleg much smaller. Gulars small, smooth,

weakly imbricate, becoming subgranular towards posterior angle of jaw. Ventrals smooth, imbricate, much larger than gulars and only a little smaller than subcaudals.

All ages and both sexes similarly coloured. Dorsal ground colour greyish to reddish brown. On each side of midline a series of black spots or irregular blotches (occasionally with pale centres) alternating with narrow, yellow or creamy white, finely black-edged transverse bars or rows of elongate spots, each coincident with a row or cluster of enlarged scales. Paravertebral spots and transverse bars on one side of body usually opposite those on other side. Pattern less uniform on lower back, and transverse bars often not collinear with those of other side. Ground colour of lateral and dorsolateral surfaces of body may be masked by intense spotting (the larger spots black, the smaller yellowish white and coincident with enlarged scales). Tail pattern variable and obscure: usually banded with yellowish white and spotted (mainly on sides) with dark brown. Top of head reddish or greyish brown. Sides of head and lower lips pale or greyish brown. Underneath buffy white, except in adult males which have a dark grey patch on chest extending narrowly on to anterior part of abdomen, and a broad median strip on throat from postmentals to preular fold. Claws colourless or pale brown, becoming darker distally.

Geographical variation.—South from the Murchison to the southern Wheatbelt there is a decrease in the relative length of limbs and tail, an increase in the number of upper labials, and a decrease in the number of subdigital lamellae. Length of appendages thus conform to Allen's rule; and the latitudinal trends in labial and lamellar counts are precisely as in the *maculatus* group.

Eastern Goldfields animals are anomalous in having fewer labials and lamellae than any of the western populations. The specimen from Lake Throssell belongs here rather than with *p. pictus*; its only peculiarity is its low foreleg-hindleg ratio (53%), which however is equalled in a specimen from Lake Varley.

Habitat.—A high proportion of these lizards came from the vicinity of saltlakes, where they excavate their short burrows among samphire growing on marginal flats or on islets in the lakes themselves. In the north and west *salinarum* is probably restricted to this sort of habitat. But in the east where alkaline soils are more general and halophytic shrubbery is widespread (either in pure communities on saltbush plains or as an understory in open woodlands) the species may be found in non-lacustrine habitats and is probably more continuously distributed than in the west.

Paratypes.—*North-West Division*: R 20537-8 (Lake Anneen, Nannine); R 21292 (Wagga Wagga); R 14879, R 20535-6, R 21293, R 22280-1 (12 mi. SE of Yalgoo). *South-West Division*: R 19015 (Waeel); R 4679 (Kulin); R 18478, R 19240, R 21533 (Lake Varley). *Eastern Division*: R 19026 (Lake Throssell); R 19029 (Cundeelee); R 14231 (Bullock Jinna, 10 mi. S of Cowarna Downs); R 13409a-c (Kalgoorlie district); R 6443 (Kurrawang). *Eucla Division*: R 19016-22 (Norseman district); R 17351,

R 19252-3 (Newman Rock, 27 mi. ESE of Fraser Range); R 283 ("Balladonia"); R 12091-2 (between Israelite Bay and Cape Arid).

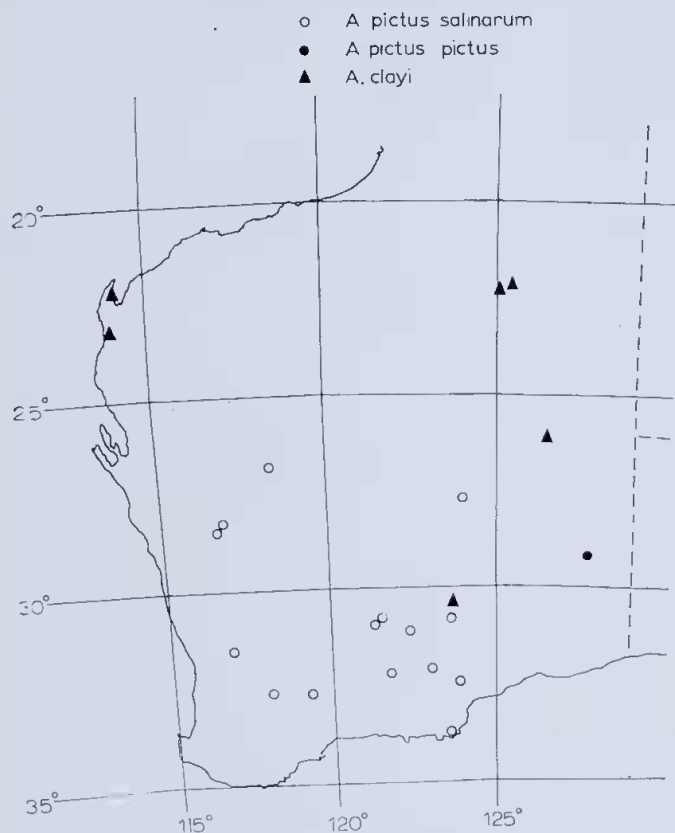


Figure 1.—Map of Western Australia, showing location of specimens of *Amphibolurus pictus salinarum*, *A. p. pictus* and *A. clayi*.

Amphibolurus pictus pictus Peters

Amphibolurus pictus Peters, 1866, Mber. Preuss. Akad. Wiss. 1866: 88. South Australia (R. Schomburgk).

Distribution.—Far southeast of Western Australia, in the vicinity of the Nullarbor Plain; thence eastwards through South Australia to western Victoria.

Diagnosis.—Distinguished from *p. salinarum* by the absence of enlarged dorsal scales and presence of nuchal crest.

Description.—Generally similar in habitus to *p. salinarum* but has a slightly narrower head (width 80% of length), a longer tail and hindleg, and a lower foreleg-hindleg ratio (50-57 against 53-62%).

Differs in scalation from *salinarum* as follows: scales on top of head higher and rougher; a series of low, laterally compressed spines along midline of nape; ordinary nuchals higher and more acute; dorsals and dorsolaterals increasing in size uniformly towards midline; suborbital series of enlarged scales more strongly tectiform; conical scales on nuchal folds (dorsolateral and subauricular) subspinose; gulars larger (in middle of throat they are not greatly smaller than pectorals, and towards posterior angle of jaw they do not become subgranular but remain imbricate). Upper labials 12-16. Femoral and preanal pores 34-48. Lamellae under fourth toe 22-31.

Dorsal colour pattern much less regular than in *salinarum*, and largely confined to vertebral region. It consists essentially of narrow black bars alternating with transversely elongate, yellow or white blotches. The black bars may have longitudinal branches along midline and along inner edge of dorsolateral stripe of ground colour (brownish or purplish grey). The pale blotches are usually black-edged and straddle midline. Flanks vaguely marbled with dark-grey and sometimes barred with yellow or white. Culmen of claws dark.

Remarks.—The provenance of R 283 (a male *p. pictus*) is doubtful, for another specimen (a female *salinarum*) has the same number, though the register contains only one entry under this number. Specimens R 275-290 were collected in 1914 by W. B. Alexander between Fraser Range and Eucla. The female could well have come from Balladonia; it is similar to females from Newman Rock (48 miles to the northwest). The male may have come from Eucla or Madura, at both of which Alexander collected reptiles. Alternatively Alexander may not have collected the male at all; its discoloration suggests that it has been preserved in formalin, and its metal tag is shiny (as though it were only a few years old); in contrast the female appears never to have been preserved in anything but alcohol, and its metal tag is eroded and tarnished, befitting an age of 50 years. At any rate, too much doubt attaches to these specimens for supposing that *p. pictus* and *salinarum* are sympatric at Balladonia.

Material examined.—*Eastern Division*: R 19032-3 (Iltoon, near Lake Ell). *Eucla Division*: R 283 ("Balladonia"). *South Australia*: R 24055 (Pidinga, S of Ooldea); SAM 3412 (Coward Springs); SAM 2620-3 (Finniss Spring, 45 mi. NE of Marree); SAM 4991 (Lake Coon-gee); SAM 4034 (Accalana crossing); SAM 3178 (Yudna Swamp, Moralana); SAM 5628 (Wooltana, Lake Frome); SAM 2782 (Beda Arm, Lake Torrens), SAM 3746 (Renmark); SAM 30 (Bow Hill, River Murray).

Amphibolurus reticulatus (Gray)

Grammatophora reticulata Gray, 1845, Cat. Liz. Brit. Mus., p. 252. Western Australia (J. Gilbert).

Grammatophora laevis Günther, 1867, Ann. Mag. Nat. Hist. (3) 20: 52. Champion Bay, Western Australia (F. H. Duboulay).

Amphibolurus darlingtoni Lovridge, 1932, Proc. New Engl. Zool. Club 13: 33. Mullewa, Western Australia (P. J. Darlington).

Distribution.—Western Australia, north to the valley of the Fortescue River and south to the central Wheatbelt (32° 30' S), thence eastward into South Australia and the extreme south of the Northern Territory.

Diagnosis.—Distinguished from both races of *A. pictus* and from *A. clayi* by the superior position of nostril, and from *A. inermis* by the alignment and number of its femoral pores and by the dark claws and palpebral granules.

Description.—Large and stout with depressed body and short, thick appendages. Snout short and sloping steeply in profile. Width of head

averages 86% of head-length, and depth of head averages 63%. Adpressed hindleg reaches to or a little beyond shoulder. Tail in adult male very thick proximally. Toes short, stout, circular in section. Maximum snout-vent length: males 108 (next largest 98), females 85.5 Gravid females range from 58.5 to 82. Smallest juvenile 27.

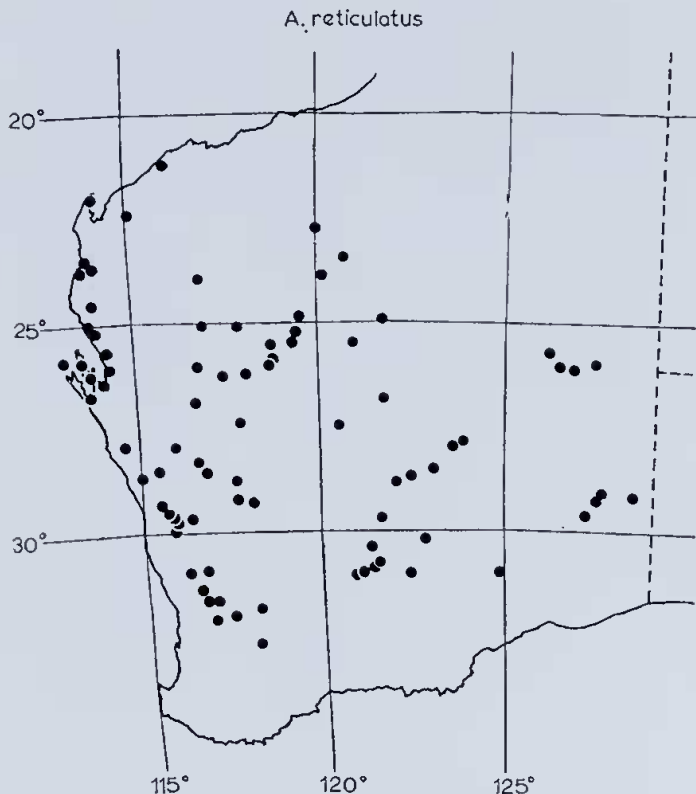


Figure 2.—Map of Western Australia, showing location of specimens of *Amphibolurus reticulatus*.

Nostril on or above swollen rostral ridge, a little nearer to orbit than tip of snout, circular and entering vertically downward. Tympanum considerably smaller than orbit, its diameter averaging 19% of length of head. Rostral and mental well developed. Upper labials 11-19. A series of enlarged tubercular scales increasing in size as they curve up from below orbit to above ear. A series of about five spines extending back from top of ear. A scattered series of about eight spines extending back from gape, below ear aperture to posterior angle of jaw where it may converge with series from above ear. A series of about eight spines arranged in well-spaced groups along dorsolateral edge of neck. (All these spines are poorly developed in juveniles, where they would be better described as tubercles). Low nuchal crest of 6-8 suberect spines scattered serially along midline from occiput to middle of nape. No dorsal crest. Strong gular fold extending obliquely backwards to above shoulder (whence in small juveniles it may continue as a weak dorsolateral fold). Femoral and preanal pores 31-55, each perforating a slightly enlarged scale, arranged close together in a straight line along outer half of thigh, extending almost to knee and narrowly interrupted at midline. Subdigital lamellae sharply bicarinate, 15-27 under fourth toe.

Scales on top of head small (larger than ordinary dorsals but smaller than supracaudals). Occipital and nuchal scales very small. Ordinary dorsal scales small, increasing in size towards midline, smooth or weakly keeled, imbricate, their free edge raised in adults. Enlarged dorsal scales about three times as large as ordinary dorsals, flatter, smooth or weakly keeled, weakly imbricate, and tending to be arranged in transverse rows. Caudal scales large, smallest laterally, imbricate and keeled, the keels aligned longitudinally. Scales on upper surface of limbs similar to but smaller than caudals, becoming smaller and weakly keeled on lower surface of foreleg, and small and smooth on outer ventrolateral surface of hindleg. Gulars and ventrals strongly imbricate, smooth or very feebly keeled.

Dorsal ground colour greyish, yellowish, or reddish brown. Underneath buffy white with or without an obscure grey network on throat (this is darker in juveniles and may extend to abdomen). Dorsal pattern changes, as follows, with age.

Juveniles have a series of black or dark brown spots on each side of midline, the spots on one side usually opposite to but sometimes alternating with those on other side. Between these spots are transverse rows of small whitish spots (each coincident with an enlarged scale), usually collinear with rows on opposite side of back. Tail barred alternately with dark brown and pale brown (dark bars on proximal part of tail may be broken by pale vertebral stripe).

In subadults the whitish transverse bars begin to disappear. A dorsolateral series of grey, elongate, dark-edged spots develops. Anterior caudal bars become obscure as interspaces darken. This is the characteristic colour pattern of adult females, only a few passing into the next stage, which is attained by males well before they are sexually mature.

In adult males the dark paravertebral and pale dorsolateral spots have merged into the dark grey or black network that prevails over head and body. Tail proximally grey or greyish brown, and distally barred with yellowish brown and dark brown. Throat yellowish. In breeding males the pale enclosed dorsal spots become vermilion, and chest and throat reddish orange.

Variation due to age and sex.—We have seen how the dorsal pattern is at first predominantly transverse, then predominantly longitudinal, and finally reticulate. Because males reach this final stage early in their development, and females only acquire it rarely, the species may be regarded as sexually dichromatic.

Throughout growth the relative length of head and limbs decrease with respect to trunk, the rate being faster in females than males. The relative length of tail, however, increases until the snout-vent length is about 50 mm; thereafter it decreases in females, but remains fairly constant in males. All appendages are shorter in females than in males of similar body size.

Geographical variation.—Generally body-size and relative length of appendages decrease with increasing winter cold. Possibly owing to sampling errors, the trends are not smooth. The

Murchison sample (consisting largely of specimens from Mileura) is especially anomalous in its short limbs.

Upper labials average 13.8 in the vicinity of Shark Bay; 14.3 at Exmouth Gulf; 15.7 round the sources of the Fortescue and Gascoyne, and in the Murchison, Wheatbelt and Warburton Range; 16.1 in the Eastern Goldfields; and 16.3 in the Laverton district. Lamellae under fourth toe average 22.2 in the upper Fortescue and Gascoyne, 21.7 at Warburton Range, 21.5 at Exmouth Gulf, 21.3 in the Murchison, 20.6 at Shark Bay, 20.5 at Laverton, 19.6 in the Eastern Goldfields, and 19.0 in the Wheatbelt. Thus, as in the *Amphibolurus maculatus* group (Storr 1965) and the western populations of *A. pictus salinarum* and *A. inermis* (this paper), labial counts tend to increase with decreasing temperature, and lamellar counts to decrease. But the two clines in *reticulatus* operate in somewhat different directions: labials more west-east, lamellae more north-south. Perhaps labials are more affected by winter temperatures, and subdigital lamellae by summer temperatures.

Although regional variation in *reticulatus* is for the most part either clinal or irregular, it may be possible when more material is available from critical areas to group the Western Australian populations into two subspecies: one inhabiting the Indian Ocean drainages, the other the interior drainages. Western animals are larger than eastern, the males averaging 6% and the females 4% longer from snout to vent. Sexual dimorphism is reduced in the east, especially as regards length of limbs. The foreleg is about as long in adult eastern females as in males, and averages about 50% of trunk, compared to 45% in western females. Eastern females are darker and redder than western females, but further east (as exemplified by a specimen from Victory Downs and one from Oodnadatta) the females are larger, paler, and less red. Males from the eastern half of Western Australia are very dark, the black reticulum is thick and so encroaches on the enclosed spots that the dorsum could be described as black, finely spotted with creamy white.

Habitat.—*A. reticulatus* occurs mainly in arid and semiarid, extratropical habitats. Its southern distribution seems to be limited more by humidity than winter cold; for it avoids the west coast south of Geraldton, i.e. as the annual rainfall approaches 20 inches. In the north it barely penetrates the tropics, and its niche is largely taken in the Pilbara region by the abundant *A. caudicinctus*.

A. reticulatus favours heavy, stony soils. Because of this preference, competition is reduced between it and the closely related *A. inermis*. *A. reticulatus* is found under logs and other natural debris, rubbish, fallen fence posts, cowturds and isolated stones and boulders, with or without a short burrow. They also shelter under exfoliating granite and behind the bark of fallen trees. At night they have been occasionally taken asleep in shrubs.

Nomenclature.—Owing to the kind offices of Miss A. G. C. Grandison, Curator of Herpetology in the British Museum (Natural History), I am

assured that the name of the foregoing taxon is *Amphibolurus reticulatus* (Gray) and that *Grammatophora laevis* Günther is a synonym of it. Miss Grandison writes (personal communication, July 29, 1964), "While the pores in female specimens in the type series of *G. reticulata* and *G. laevis* are arranged in a slightly wavy line, with each pore usually separated from its fellow, there is no tendency for their alignment to curve over to the inside of the thigh. The condition in the males also resembles more closely condition A than B [referring to my sketches of the femoral pore line in *reticulatus* and *inermis* respectively]. The number of pores in the specimens is as follows:—*G. reticulata* ♂ 20: 20, ♀ 19: 18; *G. laevis* ♂ 20: 18, ♀ 20: 20, ♀ 20: 20 juv. 22: 24."

Material examined.—*North-West Division:* R 13786 (Mardie); R 13316 (Kookhabinna Gorge, Barlee Range); R 18975-6 Koordarrie; R 18977-90 (10 mi. SE of Vlaming Head); K 411 (Kabaura Well); K 414 (Mowboura); R 8161 (Warroora); R 18991-5 (9 mi. SE of Warroora); R 18997-19000 (11 mi. S of Warroora); K 338, 341-3 (12 mi. S of Booloogooroo); R 11257 ("Bernier Island"); R 22400 (10 mi. SE of Carnarvon); R 16944 (23 mi. SSE of Carnarvon); R 21614 (6 mi. N of Wooramel); R 19948 (Yaringa North); R 13167 (Hamelin Pool); R 13127 (Faure Island); R 19001-2, R 19681-2, R 22090, R 22430-1 (Denham); R 18939-40 (Nanga); R 15797, R 18599 (Tamala); R 12456-60 (Dirk Hartog Island); R 10802 (Roy Hill); R 13594 R 18336, R 22497-9 (Jigalong); R 10801 (Mundiwindi); R 19004 (10 mi. SE of Cardawan); R 19006 (25 mi. SE of Three Rivers); R 19007 (12 mi. N of Doolgunna); R 19005 (Peak Hill); R 21291 (5 mi. S of Mt. Clere); R 2699 (Landor); R 914, R 919-22 (Milly Milly); R 15741, R 15746-53, R 15767-9, R 15795-6, R 15798 (Mileura); R 7371-2, R 7376 (Belele); R 19008 (42 mi. N of Meekatharra); R 19009-13 (36 mi. N of Meekatharra); R 738 (Cue); R 15770 (Boolarly); R 8169 (Yuin); R 4945 (Yalgoo); R 53034 (Wadgingarra); R 19014 (9 mi. S of Wydgee); R 12501, R 12508, R 12517 (Paynes Find); R 12516 (Pindabunna). *South-West Division:* R 11113-5, R 19003 (Galena); R 11128 (Eradu); R 4460 (Mullewa—a paratype of *darlingtoni*); R 10203 (Yandanooka); R 11129 (Three Springs); R 21956 (Caron); R 406 (Carnamah); R 22279 (10 mi. S of Carnamah); R 13226 (8 mi. W of Coorow); R 12829 (New Norcia); R 4240 (Wongan Hills); R 22448-9 (Culham); R 3769 (Northam); R 15832 (Meenaar); R 4505 (Beverley); R 2476, R 2480 (Quairading); R 11099 (Bruce Rock); R 4573 (Kulin). *Eastern Division:* R 15845-6 (Weld Spring); R 3894-5 (Windich Spring); R 13701, R 13705 (Mt. Fisher, 110 mi. E of Wiluna); R 12416 (Kathleen Valley); R 19065 (73 mi. E of Cosmo Newberry); R 20694-5 (Beegull Rockhole, S of Lake Throssell); R 20656-8 (White Cliffs); R 1223, R 1230, R 1752, R 22392-3 (Laverton); R 12863 (Mt. Morgans); R 21336 (Ginrock); R 19024-5 (Bardoc); R 12970-2, R 19023 (Bullabulling); R 14126-8 (Dedari); R 4746, R 6436, R 6438-42, R 6444 (Kurrawang); R 4178, R 13422 (Kalgoorlie); R 12991 (Jumnanian Rocks); R 14226-30 (Cowarna Downs); R 12973-6 (40 mi. NW of Cundeelee); R 19030 (Naretha); R 19031

(Smith's Station, 90 mi. N of Loongana); R 19243 (Elduna); R 19035-6 (Coolgarbin, west of Lake Ell); R 19034 (Booyanoo, west of Forrest Lakes); R 14630 (40 mi. NW of Warburton Mission); R 14631 (4 mi. N of Warburton Mission); R 15149, R 17740, R 17839, R 19027, R 22101, R 22107, R 22036, R 22205 (Warburton Mission); R 19028 (12 mi. E of Warburton Mission); R 15688-90, R 16522-3 (20 mi. E of Warburton Mission); R 15691-2 (Barrow Range). *Northern Territory*: R 20929 (22 mi. W of Victory Downs). *South Australia*: NTM 1527 (Lambina. Oodnadatta).

***Amphibolurus inermis* (De Vis)**

Grammatophora inermis De Vis, 1888, Proc. Linn. Soc. N.S.W. (2) 1888: 812. Central Queensland (C. W. de B. Birch).

Amphibolurus reticulatus major Sternfeld, 1919, Senckenbergiana 1: 78. Hermannsburg, Northern Territory (M. von Leonhardi).

Distribution.—Western Australia north of latitude 29° 30' S, east through the Northern Territory and northern South Australia to central Queensland.

Diagnosis.—Closely related to *A. reticulatus*, from which it is readily distinguished by the pale claws and by the sparseness and peculiar alignment of the femoral pores.

Description.—Generally similar in habitus to *reticulatus* but larger and having relatively shorter appendages. Adpressed hindleg reaches

to shoulder. Base of adult male's tail not so thick as in *reticulatus*. Maximum snout-vent length: males 115, females 98 (next largest 92). Gravid females range from 67 to 89. Smallest juvenile 31.

Generally similar in scalation to *reticulatus*, but differing as follows: spines behind and below ear smaller and arranged more in clusters than series; nuchal crest lower; enlarged dorsal scales less than twice as large as ordinary dorsals; gulars smaller (only half as large as ventrals). Diameter of tympanum averages 21% of head-length. Upper labials 12-21. Lamellae under fourth toe 17-28. Femoral and preanal pores 13-33, each perforating an enlarged scale, widely spaced on a curve that approaches mid-front of thigh, and interrupted at midline.

All ages and both sexes similarly coloured. Dorsal ground colour pale orange brown. Head and body covered with dark reddish brown network, finer than in male *reticulatus* and enclosing larger spots, and so disposed as to leave a pale vertebral stripe and occasionally dark paravertebral blotches. A few juveniles have irregularly transverse rows of small white spots. Tail obscurely barred with dark and pale reddish brown, the dark bars usually broken along midline of proximal two-thirds of tail. Palpebral and intraorbital scales much paler than in *reticulatus*, giving the eyes the appearance of being white-spectacled. Culmen of claws unpigmented (they are dark brown in *reticulatus*). Underneath whitish except for throat which in most specimens is faintly reticulated with grey.

Variation due to age and sex.—While there is little sexual or age variation in colour, there is a considerable amount in the relative length of appendages. Length of head, foreleg and hindleg, relative to trunk, decrease throughout growth. Relative length of tail remains fairly constant except for a sudden increase in maturing males. All appendages are much smaller in females than in males of similar body-size.

Geographical variation.—Throughout its wide range this species is remarkably uniform in coloration, proportions and meristics. There are only slight differences in the relative length of appendages, most of which are attributable to Allen's effect. Regional divergences from overall mean relative length of appendages are set out in Table I. Though the regions are largely artefacts of collection, such breakdown of data serves to indicate climatic effects. The tail, especially, decreases in length with decreasing July temperatures (rather than with latitude *per se*). The Warburton Range and Laverton populations are anomalous with respect to length of limbs, and the Exmouth Gulf and MacDonnell Range populations with respect to length of head.

Table II gives regional variation in meristics. In the west, from Kimberley south to the Murchison, upper labials steadily decrease in number, and subdigital lamellae increase. In the interior of the continent no such clines are evident. The high lamellar counts at Warburton Range and Laverton are associated with anomalously long hindleg. Geographical variation in number of pores is everywhere irregular, the highest and

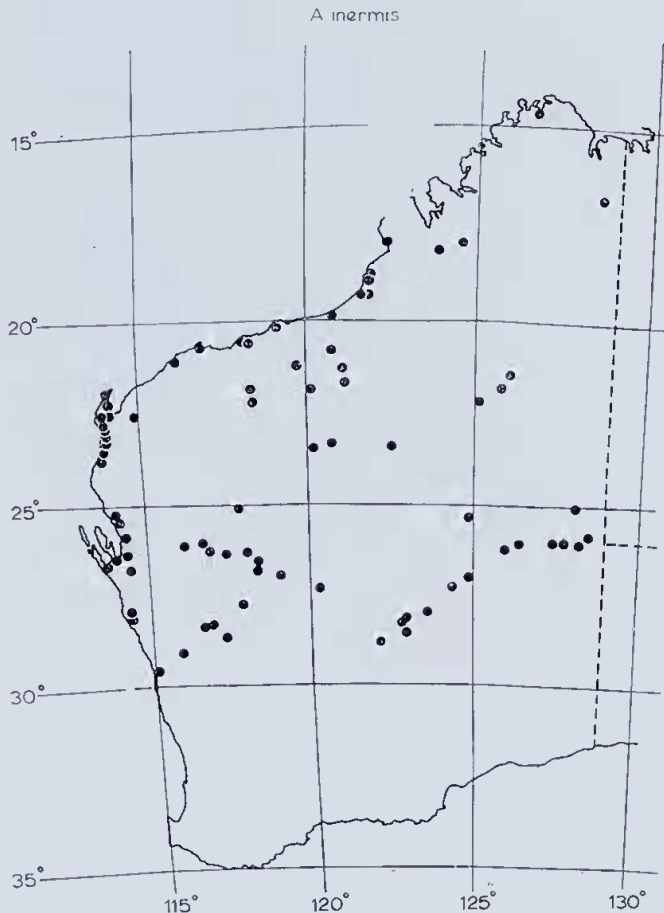


Figure 3.—Map of Western Australia, showing location of specimens of *Amphibolurus inermis*.

TABLE I

Mean regional deviation (%) from overall mean relative length of appendages in adult male *Amphibolurus inermis*. The means are of individual deviations from the means for the appropriate snout-vent length class (5 mm intervals). Latitude and temperature data are meaned for locality of specimens (not the region).

	Number of Specimens	Latitude (°S)	Mean daily temperature July (°F)	Head	Tail	Foreleg	Hindleg
West Kimberley	8	18.8	67.5	+ 5.0	+ 5.2	+ 2.9	+ 2.8
Pilbara	9	21.0	65.2	+ 2.0	+ 2.1	+ 2.1	+ 0.9
Exmouth Gulf	14	22.6	64.1	+ 0.1	+ 4.9	+ 2.4	+ 2.3
Shark Bay	7	27.1	58.9	+ 1.7	+ 1.5	+ 2.7	+ 1.5
Murchison	8	26.6	55.9	0	+ 0.2	- 1.3	- 2.8
Warburton Range	13	26.1	54.0	- 2.7	- 2.1	+ 1.4	+ 0.6
Laverton	7	27.9	52.4	- 1.5	- 8.2	- 0.3	- 0.1
MacDonnell Range (N.T.)	14	23.9	53.0	+ 0.3	- 2.8	- 0.8	- 1.6
Oodnadatta (S.A.)	3	27.5	53.3	- 4.0	- 6.3	- 0.7	- 1.2

TABLE II

Mean number of upper labials, lamellae under fourth toe, and femoral plus preanal pores, in various populations of *Amphibolurus inermis* (with standard deviations in parentheses).

	Number of Specimens	Labials	Lamellae	Pores
West Kimberley	21	15.1 (1.2)	21.9 (1.6)	23.1 (2.5)
Pilbara	60	15.5 (1.3)	21.6 (2.1)	21.6 (3.1)
Exmouth Gulf	27	16.1 (1.4)	21.6 (1.8)	20.8 (3.2)
Shark Bay	13	16.5 (1.3)	21.5 (1.9)	22.7 (2.6)
Murchison	25	15.8 (1.4)	20.7 (1.4)	22.8 (2.3)
Warburton Range	59	16.3 (1.5)	23.1 (1.2)	23.5 (2.5)
Laverton	22	16.6 (1.5)	23.4 (1.7)	25.7 (3.4)
MacDonnell Range (N.T.)	31	15.2 (1.3)	20.0 (1.6)	18.9 (2.7)
Oodnadatta (S.A.)	23	14.9 (1.2)	21.5 (1.6)	20.3 (3.9)

lowest counts (respectively at Laverton and Alice Springs) coming from climatically similar regions.

On the basis of these analyses it is possible to recognise some incipient subspeciation. The western populations (Kimberley to Murchison) are characterised by short limbs (after taking temperature into account); the central populations (Warburton Range to Laverton) by long limbs and high lamellar and pore counts; and the eastern populations (MacDonnell Ranges to Oodnadatta) by short limbs and low pore counts. Except for their more northerly extent in *inermis*, the boundaries between incipient subspecies follow much the same meridians as in *reticulatus*.

Habitat.—In contrast to *reticulatus*, the distribution of *inermis* seems to be affected more by winter cold than humidity. Its southern limits coincide with the 67° F isotherm for mean daily maximum temperature in August.

A. inermis favours sparsely vegetated, sandy to loamy plains. They are seldom found in rocky situations or where the soil is stony. They are adept burrowers, each animal apparently digging several burrows in its home-range. Infrequently a burrow may be located under a rock, sheet of iron, etc., but usually it is dug in a patch of bare soil, where a good view may be had from the burrow-mouth. Where the ground herbage is dense, burrows are apt to be concentrated in the banks of roads or in

grader spoil. On little-used roads the lizards often burrow into the "hump" between wheel-tracks. The burrows are 10-20 inches long, and twist sharply down at an average slope of 30°.

A. inermis only climbs (on to termitaria, stones, fence posts etc.) to reach the late afternoon sun. On one occasion two adults were taken from the stomach of a juvenile *Varanus gouldi*.

Material examined.—*Kimberley Division*: R 13609 (Kalumburu); R 11777 (Lissadell); R 13596 (Paradise); R 19916 (Luluigui); R 13602, R 14090-1 (Broome); R 3446, WHB (8) (La Grange); WHB (2) (Frazier Downs); WHB (2) (Mt. Phire); R 5000, R 15181 (Anna Plains). *North-West Division*: R 1039-48, R 1050, R 1052-64, R 1066-70, R 1073-5, R 1078-80, R 1083, R 1085-6 (Wallal); R 2118-9 (De Grey); R 18876-912 (Mundabullangana); R 17064 (8 mi. E of Mundabullangana); R 17069 (12 mi. E of Mundabullangana); R 17054 (4 mi. S of Nickol Bay); R 18916 (9 mi. NE of Mardie); R 10858 (Hooley); R 13996, R 18914 (Wittenoom); R 5016 (Warrawagine); R 14588 (Braeside); R 14591 (25 mi. S of Braeside); R 18913 (Marble Bar); R 13166 (Nullagine); R 13334-7, R 22495-6 (Jigalong); R 18915 (23 mi. N of Mundiwindi); R 12627 (Yanrey); R 18917 (6 mi. W of Yanrey); R 13126, R 13170-1 (Yardie Creek); R 14182 (Vlaming Head); R 14024 (North-west Cape); R 16997 (6 mi. S of North-west Cape); R 18918-20, K 417, K 420 (10 mi. S of North-west Cape);

TABLE III

Mean snout-vent length, and mean length of appendages relative to trunk, in adults (with standard deviations in parentheses). The figure in parentheses after sample-size is the number of specimens with complete tail.

Sex	Sample-size	Snout-vent Length	Head	Tail	Foreleg	Hindleg
		(mm.)	%	%	%	%
pictus salinarum	12 (12)	61.0	38.8 (1.6)	223.1 (17.5)	56.5 (2.4)	98.2 (6.5)
	11 (9)	63.0	34.3 (1.1)	190.7 (9.5)	51.5 (2.6)	90.1 (3.6)
pictus pictus	13 (12)	65.0	40.5 (2.5)	265.0 (16.8)	55.0 (2.4)	104.0 (6.8)
reticulatus	32 (25)	89.2	34.4 (2.1)	210.8 (13.4)	48.5 (3.5)	80.5 (6.3)
	30 (25)	75.7	31.7 (2.3)	179.1 (10.7)	46.3 (3.9)	76.0 (5.2)
inermis	86 (76)	101.8	32.7 (2.0)	179.1 (11.8)	47.8 (2.7)	74.3 (3.9)
	38 (33)	85.8	31.1 (1.9)	153.0 (9.5)	47.4 (2.7)	71.6 (3.3)
clayi	6 (6)	48.6	37.6 (1.2)	208.8 (13.2)	54.2 (1.2)	90.2 (3.4)

TABLE IV

Mean (M) number of upper labials, lamellae under fourth toe, and femoral plus preanal pores, with sample-size (N) and standard deviation (S).

	Labials			Lamellae			Pores		
	N	M	S	N	M	S	N	M	S
pictus salinarum	33	14.5	1.5	32	24.1	1.8	25	46.0	4.2
pictus pictus	18	14.4	1.4	16	25.8	2.4	13	42.4	4.1
reticulatus	163	15.3	1.5	164	20.8	2.0	138	39.6	5.0
inermis	296	15.7	1.5	297	21.8	2.0	291	22.1	3.3
clayi	14	16.3	2.0	14	23.4	1.5	8	6.1	1.6

R 11525, R 11529, K 459 (Learmonth); R 18921, K 361 (6 mi. S of Learmonth); K 460-1 (16 mi. SSW of Learmonth); R 18922 (12 mi. S of Exmouth Gulf HS.); R 18929-30 (18 mi. SSW of Bullara); R 16991 (16 mi. NE Ningaloo); R 13595, R 18923 (Point Cloates); R 18925-7 (12 mi. SSE of Ningaloo); R 16976 (19 mi. N of Cardabia); R 16972, R 16975 (14 mi. N of Cardabia); R 18928 (6 mi. N of Cardabia); R 18931-2 (16 mi. N of Warroora); R 8162 (Warroora); R 18924 (10 mi. SE of Gnaraloo); K 336 (32 mi. N of Wooramel); R 16939, R 17084 (21 mi. N of Wooramel); R 19947 (Yaringa North); R 13136, R 18935-6, K 335 (Overlander); R 18941 (9 mi. W of Hamelin Pool HS.); R 15800 (Tamala); K 334 (6 mi. N of Nerren Nerren); R 21289-90 (5 mi. S of Mt. Ciere); R 18937-8 (Byro); R 913, R 915-8 (Milly Milly); R 15762 (Nookawarra); R 15735-40, R 15742, R 15763-5, R 15799 (Mileura); R 7372-6 (Belele); R 19209-10 (Meekatharra); R 18943-4 (Nannine); R 18942 (Moyagee); R 20539 (Wagga Wagga); R 4946 (Yaloo); R 13963 (Burnerbinmah). *South-West Division*: R 18953 (20 mi. W of Ajana); R 16928 (7 mi. N of Balline); R 16926 (Balline); R 13474 (Lake Arromel); R 2825 (Gutha). *Eastern Division*: R 8714 (Well 42, Canning Stock Route); R 3978 (Well 39, C.S.R.); R 3938-41 (between Wells 31 & 36, C.S.R.); R 8415 (Well 19, C.S.R.); R 15745 (Youno Downs); R 19784-6, K 628, K 663-4 (Albion Downs); R 17676, R 18945 (Mt. Margaret); R 13109, R 18946-7 (Laverton); R 18948 (25 mi. NE of Laverton); R 20655 (White Cliffs); R 18949 (9 mi. SW of Cosmo Newbery);

R 18950-3 (Cosmo Newbery); R 13098 (20 mi. ENE of Yamarna); R 20704 (7 mi. SW of Nullye Rock-hole); R 18955 (18 mi. ENE of Nullye Rock-hole); R 21040 (8 mi. NW of Mt. Beadell); R 18956 (20 mi. SW of Warburton Mission); R 18957 (8 mi. W of Warburton Mission); R 15171 (5 mi. NNW of Warburton Mission); R 14616-26, R 14629, R 15151-4, R 17739, R 17762, R 17783, R 17838, R 18958-67, R 22108, R 22135-64, R 22190, R 22197-8 (Warburton Mission); R 15693-5 (Barrow Range); R 20727-8, R 20989-90 (Cavenagh Range); R 13099, R 20744-5 (Blackstone); R 20971 (Mt. Aloysius); R 20760-1 (Giles). *Northern Territory*: R 21445-52 (7 mi. E of Tennant Creek); NTM 1462 (Haast's Bluff); R 20906-7 (Alice Springs); NTM 1021-35, NTM 1052, NTM 1433-5 (5 mi. S of Alice Springs); NTM 1506-10 (Todd River Station); NTM 1476-83, R 20873 (Hermannsburg); R 20809 (Curtin Spring); R 20800-1 (Mt. Olga); R 13106, R 20772-3 (Petermann Range); R 20943 (15 mi. SW of Mulga Park); R 20940 (Mulga Park); R 20939 (40 mi. E of Mulga Park); R 20913 (Kulgera). *South Australia*: R 20969 (Tomkinson Range); R 20951 (Musgrave Park); NTM 1512-26, NTM 1546-7, NTM 1556-61 (Lambina Station, Oodnadatta).

Amphibolurus clayi sp. nov.

Holotype.—R 14462, in the Western Australian Museum, an adult male collected by G. M. Storr and B. T. Clay on November 1, 1961.

Type locality.—3 miles south of Learmonth, Western Australia, in lat. 22° 16' S and long. 114° 06' E.

Distribution.—Only known from a few localities in the Exmouth Gulf region and eastern deserts of Western Australia.

Diagnosis.—Superficially similar (in habitus and coloration) to juvenile *inermis*, but readily distinguished from that species and other members of the *A. reticulatus* group by its narrow nostrils, uniformly small dorsal scales, few pores, and black gular collar.

Description.—Small with moderately depressed body and relatively short appendages. Width of head averages 81% of its length, and depth 66% of its length. Adpressed hindleg does not quite reach to tympanum. Toes circular in section, their outer edge sharply denticulate. Maximum snout-vent length: males 53.5. Two gravid females measure 48 and 49. Smallest juvenile 24.

Nostril below moderately acute rostral ridge, a little nearer to orbit than tip of snout, slit-like or narrowly elliptical, and entering forward and downwards. Supraciliary ridge acute. Tympanum much smaller than orbit, its diameter averaging 13% of head-length. Rostral broad, as high as or a little higher than adjacent labials. Upper labials 14-21, a little larger than adjacent facials. Mental much smaller than rostral and sometimes undifferentiated from labials. A series of enlarged tubercular scales from back of orbit to top of ear aperture. No nuchal and dorsal crests. Strong gular fold extending obliquely back to above shoulder. No dorsolateral fold. Femoral and preanal pores small, 4-9 (1-2 on each thigh, and 1-3 on each side of preanal region), each located between four unenlarged scales. Subdigital lamellae sharply bicarinate (the inner series of keels much the higher), 21-27 under fourth toe.

Scales on top of head subtubercular, small (but larger than dorsals and nearly as large as supracaudals). Occipital and nuchal scales granular except along midline of neck where they are larger and tubercular. Dorsal scales subgranular, becoming larger and weakly keeled and imbricate along midline. Scales on top of limbs and tail larger, weakly keeled and imbricate. Scales under tail still larger and more strongly keeled and imbricate, their keels aligned longitudinally. Gulars small, smooth, strongly imbricate. Ventrals larger (but not so large as subcaudals), mucronate, strongly imbricate, feebly keeled.

Dorsal ground colour of juveniles yellowish brown. A series of dark brown blotches on each side of pale vertebral stripe (which extends from nape to end of tail), alternating with vaguely defined buffy white transverse bars. A jet black elongate spot on lateral extension of

gular fold, which may be joined to its opposite number by a narrow black bar along gular fold. Whitish below.

With maturity the ventral surface becomes buffy white, the dorsal ground colour pale orange-brown, and the dorsal pattern (especially in males) largely absorbed in a dark reddish brown reticulum, which is so disposed as always to leave a pale vertebral stripe and sometimes a discontinuous, ill-defined dorsolateral stripe.

Remarks.—Named after Mr B. T. Clay of the Zoology Department, University of Western Australia, who helped me collect the holotype and much other material in the North-West Division.

This species is possibly not so rare as its belated discovery would suggest, and its scarcity in collections could be due to its unobtrusive behaviour. The two specimens collected by Clay and me in the Exmouth Gulf region were virtually obtained by accident. The holotype was shot on the edge of the road after we stopped to examine a dead *Pseudechis australis*. At the same place we collected *Amphibolurus isolepis* and *A. barbatus*. The other specimen (R 14463) was dug from a burrow in the middle of the road, after we stopped to collect a *Moloch* on a low red sand-dune vegetated with *Triodia* and scattered low shrubs. A *Varanus gouldi* was observed here.

The denticulate toes and narrow nostrils suggest that *clayi* is adapted for living in loose sand. Both features are more strongly developed in the dune-inhabiting iguanid, *Uma*, of western North America.

One of Mr de Graaf's four specimens from the Warburton Mission was identified by aborigines as "mutukala", and another as "tjimpilka". The first of these names is usually applied to *A. inermis* and *A. reticulatus*, and the second to *A. isolepis*. Trouble with this genus is clearly no prerogative of white man.

Paratypes.—*North-West Division*: R 14463 (5 mi. E of Cardabia). *Eastern Division*: R 3944 (between Wells 31 and 36, Canning Stock Route); R 3968 (Well 37, Canning Stock Route); R 14628, R 21998, R 22006, R 22042 (Warburton Mission); R 12941-5, R 13549 (Queen Victoria Spring).

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